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ABSTRACT

The use of health-related physical fitness tests for sex-fair ability grouping in physical education classes requires the verification of two assumptions: (1) that there exists a direct positive relationship between health-related physical fitness and development and/or improvement of various sport skills; and (2) that there is a physiological capability of both sexes to perform equally on health-related physical fitness test items. Health-related physical fitness tests involve cardiovascular function (1-mile run), body composition (triceps and subscapular skinfolds), and musculoskeletal function of the abdominal and low back region (timed sit-ups and sit and reach exercises). A comparison of selected percentile norms from the AAHPERD (American Alliance for Health, Physical Education, Recreation and Dance) Health Related Physical Fitness Test Manual shows that, with the exception of the flexibility item, if percentile scores are used for classification, true homogeneous groups based on absolute fitness will not be achieved. The use of absolute scores to achieve sex-fair groups would require the establishment of criterion-referenced norms for the individual groups and probably result in an unequal sex, but equal fitness, distribution of students. (Author/JD)

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The Use of Health Related Physical Fitness Tests to Achieve Sex Fair Ability Grouping of Students in Junior and Senior High School Physical Education Classes

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Aostract

The use of health related physical fitness tests to achieve sex fair ability grouping in junior and senior high school physical education classes first requires an understanding of what health related physical fitness is. This is defined as a multifaceted construct related to functional health. In particular, it is concerned with tests of cardiovascular function (1 mile run), body composition (triceps and subscapular skinfolds), and musculoskeletal function of the abdominal and low back region (timed sit-ups and sit and reach). The utilization of these tests for sex fair ability grouping in physical education classes then requires the verification of two assumptions: 1) that there is a direct positive relationship between health related physical fitness and the development and/or improvement of a variety of sport skills; and, 2) that males and females are physiologically capable of equal performances on the health related physical fitness test items. Evidence is presented to substantiate the first assumption, but not the second. A comparison is made of selected percentile norms from the AAHPERD Health Related Physical Fitness Test Manual which shows that, with the exception of the flexibility item, if percentile scores are used for classification true homogeneous groups based on absolute fitness will not be achieved--the boys will be better. The use of absolute scores to achieve sex fair groups would require the establishment of criterion referenced norms for the individual groups and probably result in an unequal sex, but equal fitness, distribution of students.

Before it is possible to discuss the use of health related physical fitness tests to achieve sex fair ability grouping it is important to define what health related physical fitness is, what it is not, and to distinguish this from motor or skill related fitness. The definitions used will be those accepted and endorsed by AAHPERD as reflected in the recently published Health Related Physical Fitness Test Manual.(1).

Physical Fitness is defined as a multifaceted construct related to functional health. It deals with those aspects of physiological function which offer some degree of protection against hypokinetic or degenerative diseases. This is in direct contrast with what can be called motor, athletic, or skill related fitness, which are those qualities of function that enable the individual to perform sports better. The specific areas of dynamic functional health which have been identified as being of national concern and have been shown by medical and/or research findings as being influenced by systematic exercise are cardiovascular function, body composition, and musculoskeletal function, particularly of the abdominal and low back region. The rationale for the selection of these areas has been extensively discussed elsewhere (14). This type of fitness is important to each and every individual at all ages and stages of life. Each of these fitnesses, however, lie on a continuum--a continuum that extends from levels of severely limited

dysfunction to high levels of optimal function. Thus they can also be important components of performance in many sports. The difference lies in the degree of development that would be needed for the "average" person as opposed to the "athlete."

These basic components of health related physical fitness are measured by the one mile or nine minute run (with the option of 1.5 miles or 12 minutes for those 13 years or older), triceps alone or triceps and subscapular skinfolds summed, one minute (curl) sit-ups, and the sit and reach.

Ultimately it must be the individual school district or teacher's objectives for physical education students which determine how students are grouped, taught, and evaluated. The following discussion, however, is predicated on the fact that at least one basic objective is common to all physical education programs - that is, the development and/or improvement of a variety of sport skills. Therefore, in order to use the health related physical fitness tests as a means of achieving sex fair ability grouping two basic assumptions must be verified:

1. That there is a direct positive relationship between health related physical fitness and the ability to learn and/or perform sport skills;

2. That males and females are physiologically capable of

equal performances on the health related physical fitness test items.

1. No studies have been found in the literature which have directly investigated the relationship between health related physical fitness as defined above and the ability to learn psychomotor/sport skills. This was to be expected, for although the concept that physical activity is important to the health of individuals is as old as the profession the current push for health related fitness is just being made in the schools. There is, however, some indirect evidence.

Voll (17) collected anthropometric and physical fitness measurements on 24 female college students to determine if ability in basic modern dance skills could be predicted. Included among these selected variables were flexibility, abdominal strength and cardiovascular fitness. A regression equation with a multiple R of 0.8678 was obtained based on 5 anthropometric and 2 physical fitness tests leading the author to conclude that such prediction was possible.

The strong relationship between strength and psychomotor skill/sport improvement can be easily documented. Clarke (5) has reviewed numerous studies which have shown that not only does strength development improve speed of movement and muscular power, but it also is beneficial for improved skill performance in at

least baseball, softball, swimming, football, and track and field. Logic and experience in athletics would support the expansion of this list to practically every sport. However, in these situations the exercise developmental programs were designed specifically to strengthen the muscles involved in the performance of the particular task or sport. The health related physical fitness test measures strength only in a very peripheral way and in a single isolated anatomical area. The one minute (curl) sit-up is really a strength/endurance task and the abdominal region may or may not reflect total body strength/endurance. Thus the prediction of sport success from health related fitness seems most most tenuous in this area.

Some form of body structural measurement has often been utilized by physical educators as a means of classifying students into homogeneous groups. thereby acknowledging that performance is affected by the size and shape of the body (10). The McCloy classification system utilized age, height, and weight in three separate indices for elementary, secondary and college age students. Correlations ranging from 0.57 to 0.81 were obtained between McCloy's system and selected sports (10). Neilson and Cozens also developed a classification index based on age, height and weight. Separate norms for the AAHPER Youth Fitness test were developed using this classification system. However, it was later found to

offer little additional information beyond age alone and dropped (10). The Wetzel grid evaluated body build by plotting height and weight in physique channels. When performance was compared to physique development according to the Wetzel Grid it was consistently found that the "heavy physique, obese" boys were the poorest (10).

A major criticism of these age-height-weight systems was that they did not take into account body composition--the proportions of muscle, fat and bone. This criticism has been met to some extent by the use of skinfolds in the health related physical fitness test. While skinfold measurements in children cannot be directly converted to percent body fat the measure itself is of the amount of subcutaneous fat occurring at the selected sites.

The reasoning behind the negative relationship between body composition and performance is partially mechanical and partially physiological. Adipose tissue, wherein body fat is stored, is not metabolically active in producing ATP energy in the same way that muscle cells are (9). Thus an individual who is overfat not only requires more energy to move his or her body, but also has proportionally less muscle mass to produce it. In addition, in events requiring muscular force the lower muscle mass means less force potential. Conversely, those possessing high quantities of muscle mass have high potential for both force and energy production. From this it should be expected that those individuals who are

the most successful in athletics will have low % body fat values. While there is some variation among sports and within positions of the same sport this generalization is valid. The average college male is composed of approximately 15% fat; the average male athlete is more likely to vary from 3-9% (track runners, gymnasts, wrestlers and body builders) to as high as 19% (football linemen and field event participants) (19). The typical female's body fat is 24-25%. Champion gymnasts have been found to average 13% with a low of 9% being reported for Russian Olympians. Female track sprinters and distance runners average 18% body fat although some have been measured as low as 6%. Swimmers have been found to possess approximately 19% fat and skiiers and field event participants 24% (13). Thus it would seem that at least from a physiological/performance standpoint there is some validity in classifying students by body composition.

The cardiovascular portion of the health related physical fitness testing is designed to test the body's ability to transport and process oxygen. Since the heart can only produce energy aerobically (11) this function is often literally a matter of life and death. The ability to produce large quantities of energy aerobically is also critical to some sport activities. Those events which require longer than 3 minutes of continuous exertion (the 1,2, 3, 6.2 and 26+ mile runs, 2000 meter rowing, 400 meter

swim, 10000 meter skate, etc.) are predominately aerobic events--that is, events wherein 60% or more of the energy is supplied through the direct processing of oxygen (9). However, when the intensity of effort exceed the ability to process oxygen the body can compensate by utilizing anaerobic means for energy production. The traditional short and middle distance events as well as most sports (golf, tennis, football, basketball, baseball and volleyball) are predominantly anaerobic (9). In these situations the ability to store large quantities of ATP and CP and to tolerate high levels of lactic acid become critical. Despite this metabolic dichotomy it is important to realize that almost all athletes in all sports acknowledge the importance of an "aerobic base"--a solid foundation upon which anaerobic development can be imposed. This is exemplified by the fact that most successful athletes possess high levels of maximal oxygen uptake values. While the normal 20-29 year old male in Cooper's fair or good category (6) has a max $\dot{V}O_2$ of 36-46 ml/kg/min baseball,basketball, cycling, canoeing, football (excluding defensive linemen), gymnastics, ice hockey, orienteering, skiing, skating, swimming, track and wrestling competitors have all been shown to exceed this value (19). Likewise, the typical 20-29 year old female's values of 29-37 ml/kg/min (6) have been exceeded by basketball, cycling, volleyball, track, cross country, swimming, skating and gymnastic athletes (13,19).

In summary, it does appear that there is sufficient evidence to link health related physical fitness measures to sport performance. They are probably not specific enough to predict success in any given sport, but physical education classes provide a variety of activities, and a solid base in the health related fitness area should be of benefit in enabling the students to practice and play without undue fatigue and a high probability of success.

2. The second assumption, i.e., that males and females are physiologically capable of equal performances on the health related physical fitness items, in more difficult to support.

The average male is approximately 30-40% stronger than the average female at all ages (18). However there is some variation dependent upon body part tested. Leg strength, as measured in pounds of force per kg of body weight is very similar between the sexes: when expressed relative to kg per lean body mass the values are essentially identical or may even favor the female. However, the average male always exceeds the average female in upper body strength. The female does have the potential to improve her strength values far above those typically seen, but due to differences in testosterone and, concomitantly, total muscle mass whether she will ever equal the male in strength remains conjecture.

Table 1 illustrates percentile norms at what are considered low (25th), borderline (50th) and good (75th) levels for abdominal

strength/endurance scores. If percentile values (which are relative to the total population of boys and girls) are used for grouping the boys will actually be better in terms of absolute fitness. If the absolute number of sit-ups is used for grouping the relatively better girls will be grouped with relatively poorer boys.

Flexibility values generally show the opposite--that girls are more flexible than boys (10). From Table II it can be seen that if percentile values are used for grouping, the girls will actually be more flexible and; conversely, if the absolute amount of stretch is used the relatively higher boys will be group with the relatively poorer girls.

Girls have more adipose tissue than boys at all ages from about 6 years onward (4). In terms of body composition, the average female is approximately 10% more fat than the average male (18). The female has both less absolute muscle tissue and more absolute fat weight than the male. Behnke (2) considers the difference to lie in what he calls essential fat--fat that is part of cell membranes for instance, and stored in the breasts and other sex specific tissue. The higher levels of estrogen in the female are at least partially responsible for her normally high % body fat. How low the female can or should go in fat is another area of speculation.

The norms in Table III are dramatic in terms of sex differences. In terms of absolute values there is a 50 percentile difference

between the males and the females. A grouping using these scores would combine high ranking females with very low males. The use of percentile ranks would again mix absolutely diverse individuals.

The difference in maximal aerobic capacity (often taken as synonymous with cardiorespiratory function) in normal sedentary individuals ranges from 10-20% between the sexes. When more fit females are compared to less fit males there is considerable overlap in values, However, again, when the male athlete is compared to the female athlete he has a 20-25% advantage. Thus, while the female is certainly capable of training her cardiovascular system, even the highest trained female does not equal a similarly trained male (4). The reasons for this are probably twofold: hemoglobin and heart size. While the oxygen carrying capacity per gram of hemoglobin is independent of sex, the hemoglobin concentration (gm/100 ml blood) is higher in the male after the age of 12 . Thus the female cannot carry as much oxygen. In addition, no matter how the comparison is made, by absolute size or relative to body size, the female heart is smaller than that of the male. Since heart size is directly related to stroke volume (the amount of blood ejected per beat) a reduced value here also impedes maximal oxygen transport (7). It seems unlikely that changing cultural and psychological expectations will influence these factors.

The pattern in Table IV is repetitive of both the sit-up and

skinfold rankings. The boys' performances are absolutely better for each percentile.

Thus, while there is a scientific basis in ability grouping students in physical education classes according to health related physical fitness test results due to the relationship between fitness and sport performance, it is doubtful if sex fair grouping can be achieved on this basis if the aim is to achieve numerically equal coeducational classes. Division by percentile score would not produce truly homogeneous groups based on fitness level. In absolute terms the boys would still be in better condition. Grouping by absolute scores would achieve homogeneous groups based on fitness level, but would also probably result in some variation of these three levels:

1. Those who score the highest--many boys with a very few girls;

2. Those who score in the middle range--the high girls and average to poor boys;

3. Those who score low--the average and poor girls and the very poor boys.

In addition to these considerations it should be noted that the AAHPERD Health Related Physical Fitness Test (1) does not allow for or encourage a composite score. This can be overcome by converting the percentile scores to z scores (16) which in turn

can be averaged to achieve a single score for classification. In order to use absolute scores criterion referenced standards would have to be developed for each of the needed number of classification groups. If all 4 tests were used there would be the problem of what to do with students who reached only part of the criteria for a given level. The alternative would be to rank the tests in order of importance and to classify simply on the basis of the primary test. Although many rankings are possible the order of 1)mile run, 2)skinfold, 3) sit-ups, and 4) sit and reach seems most logical based on the information discussed before. Scheduling individuals on the basis of health related physical fitness test results could either be a monumental task or a relatively simple one depending upon individual school situations. Large schools with several teaching stations would probably find this easiest. Even if grouping could not be done by individual class, it could be done within each class. The now famous La Sierra Program (3) used a system of different colored uniforms for students of varying fitness levels. This enabled squads to be separated or mixed easily for conditioning work, drills and games, and would be logistically feasible in most schools. The state of the science at this moment is such that no compensations are known to be necessary of possible for ethnic or racial differences in health related fitness testing. Class length should pose no problem in grouping by these tests.

Based on the above discussion, the following seem to be the advantages and disadvantages of using health related physical fitness tests to achieve sex fair ability grouping.

Advantages:

1. The teacher should be able to devise drills and game situations based upon a known level of physiological capacity.

2. Since high fitness and high skill often go together those students who are in this classification will be able to progress faster and further in class. Conversely, those in the lower levels would not be pushed beyond reasonable limits.

3. Such classification would comply with the law since ability grouping is permissible if based on individual performance (16).

Disadvantages:

1. The net result would probably be less truly coeducational classes and more that are dominated by one sex or the other.

2. While the health related physical fitness items are basic to many physical activities supplemental motor fitness tasks are necessary to truly determine fitness for any given sport.

Recommendations:

1. Since there is virtually no research available which deals directly with the use of health related physical fitness tests to achieve sex fair ability grouping this is an area which should be investigated.

2. All students of both sexes should be given help and encouragement in achieving reasonable levels (above the 50th percentile) of health related physical fitness. Since skill development is linked to an ability to practice often, hard, and sometimes long, this would serve a dual purpose of benefit to each individual.

3. If the aim is to achieve coeducational classes with relatively equal numbers of boys and girls the health related physical fitness tests must be used with caution. If the aim is to achieve coeducational classes where the basic ability to practice and play competitively on a relatively equal level is the aim, the health related fitness tests might prove a useful tool.

Table I

Selected Percentile Norms--Sit-ups

Boys and Girls 12-17 (1)

75th	12	13	14	15	16	17 years
Boys	46	48	49	49	51	52
Girls	41	41	42	43	42	44
50th						
Boys	39	41	42	44	45	46
Girls	36	35	35	37	33	37
25th						
Boys	31	35	36	38	38	38
Girls	30	29	30	30	29	31

Table II

Selected Percentile Norms--Sit and Reach (cm)

Boys and Girls 12-17 (1)

75th	12	13	14	15	16	17 years
Boys	29	30	33	34	36	40
Girls	34	36	38	41	39	40
50th						
Boys	26	26	28	30	30	34
Girls	30	31	33	36	34	35
25th						
Boys	21	20	23	24	25	28
Girls	25	24	28	31	30	31

Table III

Selected Percentile Norms--Sum of Triceps and Subscapular Skinfolds (mm) Boys and Girls 12-17 (1)

75th	12	13	14	15	16	17 years
Boys	11	12	11	12	12	12
Girls	15	16	18	20	20	20
50th						
Boys	15	15	14	14	14	15
Girls	19	20	24	25	25	27
25th						
Boys	21	22	20	20	20	21
Girls	27	30	32	34	34	36

Table IV

Selected Percentile Norms--One Mile Run (min:sec) Boys and Girls 12-17 (1)

75th	12	13	14	15	16	17 years
Boys	7:24	6:52	6:36	6:35	6:28	6:36
Girls	8:36	8:18	8:13	8:42	9:00	9:03
50th						
Boys	8:20	7:27	7:10	7:14	7:11	7:25
Girls	9:47	9:27	9:35	10:05	10:45	9:47
25th						
Boys	10:00	8:35	8:02	8:04	8:07	8:26
Girls	11:35	10:56	11:43	12:21	13:00	11:28

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